CC/NUMBER 14
APRIL 5, 1982

This Week's Citation Classic

Dolph C L. A current distribution for broadside arrays which optimizes the relationship between beam width and side-lobe level.
Proc. IRE 34:335-48, 1946.
[Bell Telephone Laboratories, Murray Hill, NJ]

A one parameter family of current distribution is derived for symmetric broadside arrays. The distribution has all side lobes at the same level and minimizes beam width for side lobes of a given level. [The *SCI*® indicates that this paper has been cited over 120 times since 1961.]

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March 8, 1982

"During World War II, I worked first as a civilian, and then as an ensign in the Combined Research Group (CRG) at the Naval Research Laboratory, Anacostia Station, Washington, DC. This group was half American and half British (from Malvern). Our task was to design and develop an IFF (identification, friend or foe) system to be used jointly by the British and US Navies. It was a distinguished group. Cleeton, the first man to work at 50,000 megacycles, was the American head while his British counterpart was Bowden (now Lord Bowden).

"Before joining CRG I had worked on direction finders used for submarine detection. It was not surprising then that my first CRG task was to compute the propagation curves over water for L band, the frequency to be used by the IFF system. Once this job was complete it was a natural step to join the antenna group headed by V.H. Rumsey—he is now at the University of California, La Jolla. The system decision was to use arrays for the IFF system—and Rumsey wanted a way to control the side-lobe level on a linear antenna array. I soon discovered a correspondence between the nulls of the pattern and the roots of complex polynomials on the unit circle in the complex plane. Later I was to learn that Schelkunoff[1] had anticipated me in this observation. However, it furnished a clue—could one modify the known properties of the Tchebyscheff polynomials to obtain a current distribution for an array which would have adjustable side lobes all of the same height?

"While I felt confident that it was possible, the means escaped me for some time. One afternoon as the Civil Service's reins were unusually heavy I decided to stay at work. Suddenly it became crystal clear how to design a distribution whose side lobes were all at the same height. As a bonus, the resulting distribution turned out to be optimal in the sense given in the above abstract. I then had the job of convincing Rumsey and Bowden that I was correct. I succeeded and Rumsey designed and built an array using this distribution. It worked. I was encouraged to stay out of the antenna shack where the measurements were made as they claimed nothing would work as soon as I picked up a screwdriver.

"This highly cited paper resulted in the J. Browder Thompson Award from the Institute of Radio Engineers for me and this work has had great influence in array theory, acoustical as well as electromagnetic, and in circuit theory. A recent application of these ideas can be found in the paper by F.J. Harris.[2] There is even a Dolph-Tchebyscheff window.

"The antenna work was instrumental in the founding of Hughes Aircraft. In fact, their first contract was from the Navy. It was for $11 million to build these arrays.

"As a final note, the CRG system for IFF was not finished in time to be used in World War II. It is, I understand, the basis of the Mark 12 system currently in use. The arrays themselves are used extensively at airports for IFF.

"This paper has been highly cited because it had important implications for antenna design, filter design, and quite recently, for harmonic analysis with the discrete Fourier transform. It led to Hughes Aircraft and from there antennae still in use evolved for the Navy and for airport identification."

1. **Schelkunoff S A.** A mathematical theory of arrays. *Bell Syst. Tech. J.* 22:80-107, 1943.
2. **Harris F J.** On the use of windows for harmonic analysis with the discrete Fourier transform. *Proc. IEEE* 66:51-83, 1978.